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March 12, 2018

Bureau of Land Management
Attn: Mike Robinson
Casper Field Office
2987 Prospector Drive
Casper, Wyoming 82604

Re: Converse County Oil and Gas Project EIS

Via email: WY_ CasperMail@blm.gov

Dear Mr. Robinson,

Environmental Defense Fund (EDF) is an environmental non-profit organization with over two million members, many of whom care deeply about the pollution emitted from oil and gas sources and the continued viability of greater sage grouse and the ecosystems upon which they depend. EDF has long participated in efforts to identify and facilitate meaningful collaborative strategies to improve air quality and to benefit sage grouse populations.

I. Air Quality

BLM has proposed to approve of an immense new oil and gas project (Converse County Oil and Gas Project) in an area of Wyoming already home to significant oil and gas activity. This new project will contribute thousands of tons of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) to the regional air shed annually, over one thousand tons of carbon dioxide equivalent (CO_2e) emissions per well at the peak of production activity, and a suite of hazardous air pollutants (HAPs), including known human carcinogens. Astonishingly, BLM's proposal is completely devoid of any measures that will reduce these harmful smog-forming, climate-altering and toxic air pollutants beyond those required by federal and state laws. This is despite the fact that EDF provided detailed information on cost-effective, technically feasible measures to reduce VOCs, methane and HAPs to BLM. The Draft Environmental Impact Statement (DEIS) fails to address these comments in any meaningful way. BLM's discussion of alternatives that were considered, but eliminated, is also completely devoid of any meaningful analysis of such alternatives, including the measures EDF suggested. The DEIS is also rife with inaccuracies regarding emission reduction federal requirements applicable to the new wells. For these reasons, it is clear that BLM failed to take a hard look at the air quality impacts and potential mitigation measures as required by NEPA, and that BLM failed to "rigorously explore and objectively evaluate" all reasonable alternatives to its proposed action, as required by NEPA.[1] Accordingly, BLM must go back, provide full consideration of cleaner alternatives, including an alternative that would require operators to use cost-effective, feasible measures to reduce emissions such as a quarterly leak detection and repair provision, and re-issue the DEIS after rigorously exploring and objectively evaluating cleaner alternatives as required by NEPA.

Overview of Project and Preferred Alternative

The Converse County Oil and Gas Project (the Project) consists of approximately 5,000 oil and natural gas wells on 1,500 new well and production pads,[2] two gas processing plants, two centralized processing facilities, and 50 compressor stations,[3] over a ten-year period.[4] Development is proposed at a rate of 500 wells per year for a 10-year period. The Project encompasses approximately 1.5 million acres of land, of which approximately 88,466 surface acres (six percent of the Project area) and 964,566 subsurface mineral estate acres (64 percent of the Project area) are public lands administered by the Bureau of Land Management (BLM), while United States Forest Service (USFS) manages approximately 63,911 acres of surface within the Project area.[5] Project emissions include NO_x, VOCs, HAPs, greenhouse gas (GHG) emissions, as well as CO, SO_2, PM_{10}, and $PM_{2.5}$.[6] The Project is estimated to contribute 10,696 tpy of NO_x and 15,506 tpy of VOCs.[7] The direct GHG emissions from the Project would range from a maximum of 6.061 MMT CO_2e at Project year 10 to a minimum of 0.019 MMT CO_2e at Project year 40, which results in approximately 1,212 tons of CO_2e per well at peak GHG emissions levels and a total of 861.82 MMT CO_2e through the life of the Project.[8]

Despite the significant amounts of estimated pollutants from the Project, BLM has proposed zero control strategies that will reduce methane, VOCs or NO_x from the Project. The only proposed measure to reduce air quality impacts is a requirement that gas plants and compressor stations located on BLM surface estate must be located at least 2,000 meters from residences or other occupied dwellings.[9] While this is an important measure for safety, it in no way will reduce emissions.

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[1] *New Mexico ex rel. Richardson v. Bureau of Land Mgmt.,* 565 F.3d 683, 703-04 (10th Cir. 2009) (citing 40 C.F.R. § 1502.14).
[2] Converse County Draft Environmental Impact Statement, Abstract, p. 1, lines 33-34 (Jan. 26, 2018) (hereinafter "DEIS").
[3] DEIS, Ch. 2.4.4, p. 2-28, lines 43-45; p. 2-29, lines 13-14.
[4] DEIS, Ch. 1.1, p. 1-1, lines 32-34.
[5] DEIS, Ch. 1.1, p. 1-1, lines 11-20.
[6] *Id.* at Ch. 4.1, p. 4.1-1, lines 16-17; total emissions by pollutant and Project year are provided on Table 4.1-5.
[7] *Id.* at Ch. 5.3, Table 5.3-2.
[8] *Id.* at Ch. 4.1, p. 4.1-16, lines 2-4; Table 4.1-6.
[9] *Id.* at Ch. 4.1, p. 4.1-35, lines 2-5.

The failure to propose any clean air measures that would reduce emissions and wasteful practices such as venting, flaring and leaking of natural gas is particularly problematic in light of the fact that BLM has proposed to rescind or scale back its own waste prevention rule.[10] This rule requires operators to reduce waste and methane emissions from the venting and flaring of associated gas, liquids unloading activities, storage tanks, pneumatic devices and pumps—all major sources of waste and pollution. Indeed, BLM's own analysis of its rescission and revision proposal demonstrates that the action, if finalized, will result in a significant drop in natural gas production on public lands – as much as 299 billion cubic feet of natural gas – enough energy to heat nearly 500,000 homes each year for the next ten years. The BLM also found that its plan would cost Americans more than $1 billion dollars in wasted natural gas and pollution. ($824 million worth of natural gas; $259 million in lost public benefits due to increased methane emissions).

BLM cannot point to Wyoming standards to fill the gaps in the DEIS with respect to mitigation measures to reduce wasteful leaks and the venting and flaring of associated natural gas. The Wyoming Department of Environmental Quality permitting guidance for this portion of the state does not require operators to conduct quarterly leak inspections, as is required for operations located elsewhere in the state. This requirement has been effective in restoring healthy air to the citizens of the Upper Green River Basin, as evidenced by the fact that the area is now on track to regain attainment with the federal health-based standards for ozone. At least quarterly or continuous leak inspections is essential to preventing waste and harmful emissions that degrade air quality. BLM must ensure that actions on its land do not cause undue degradation to air quality or waste.[11] Failure to provide due consideration to an alternative that analyzes the feasibility of requireing operators to conduct quarterly inspections or install continuous monitors is a fatal flaw in the DEIS.[12]

BLM'S INVENTORY ESTIMATES LIKELY UNDERESTIMATE EMISSIONS, INDICATING THAT ITS MODELING IS LIKELY INCORRECT

The DEIS contains an estimate of VOC and CO2e emissions from the proposed project. According to the Draft EIS' estimates based on the BLM's inventory, oil and gas activities on state lands in Wyoming are expected to emit 81,160 tons of VOCs in 2028, 43,467 tons of NO_x in 2028[13] and a total of 861.82 MMT CO_2e through the life of the Project.[14] As discussed in our scoping comments, these numbers likely significantly underestimate actual emissions, as a series

[10] BLM, *Waste Prevention, Production Subject to Royalties, and Resource Conservation; Rescission or Revision of Certain Requirements*, 83 Fed. Reg. 36, 7924 (Feb. 22, 2018), *available at* https://www.gpo.gov/fdsys/pkg/FR-2018-02-22/pdf/2018-03144.pdf.

[11] Fed. Land Policy & Mgmt. Act, 43 U.S.C. §§ 1701(a), 1732(b); 43 C.F.R. § 3809.5; Mineral Leasing Act, 30 U.S.C. § 225.

[12] *See New Mexico ex rel. Richardson,* 565 F.3d at 703-04 (citing 40 C.F.R. § 1502.14) (An EIS must "rigorously explore and objectively evaluate" all reasonable alternatives to a proposed action, in order to compare the environmental impacts of all available courses of action).

[13] *Id.* at Ch. 5.3, p. 5-18, Table 5.3-2.

[14] *Id.* at Ch. 4.1, p. 4.1-16, lines 2-4; Table 4.1-6.

of scientific studies demonstrate that measured emissions are magnitudes higher than estimates based on emission factors and engineering calculations.

A. Field Studies Using Direct Measurement Demonstrate that Actual Emissions are Significantly Higher than Inventories Estimations.

Up until recently, regulators have relied nearly exclusively on emission inventories to understand the magnitude of a pollution problem as well as the potential reductions associated with a proposed solution. Now, however, recent advances in science have added to our knowledge and understanding of emissions from oil and gas facilities. These studies demonstrate that emissions are systematically significant and, at a select number of facilities, actual emissions are magnitudes higher than emission inventories suggest. From a policy standpoint, they point clearly to the need for frequent inspections to identify abnormal operating conditions and malfunctioning or defective equipment.

A recent series of studies in the Barnett—incorporating both top-down and bottom-up measurement—found that emissions were 50 percent greater than estimates based on the GHGI.[15] The studies partially attributed these large emissions to high emission sites not reflected in inventories, which focus on average emission factors. One study in particular found that a small number of sources are responsible for a disproportionate amount of emissions, noting specifically that "sites with high proportional loss rates have excess emissions resulting from abnormal or otherwise avoidable operating conditions, such as improperly functioning equipment."[16]

In addition, a helicopter study of 8,220 well pads in seven basins, including sites in Eastern Wyoming's Powder River Basin, confirms that leaks occur randomly and are not well correlated with characteristics of well pads, such as age, production type or well count.[17] That study focused only on very high emitting sources, given the helicopter survey detection limit which ranged from 35–105 metric tons per year of methane. The paper reported that emissions exceeding the high detection limits were found at 327 sites. 92 percent of the emission sources identified were associated with tanks, including some tanks with control devices that were not functioning properly and so could be expected to be addressed through a leak detection and repair program. While the study did not characterize the individually smaller but collectively significant leaks that fell below the detection limit, it nonetheless confirms that high-emitting leaks occur at a significant number of production sites and that total emissions from such leaks are very likely underestimated in official inventories.

Other studies have found similar results:

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[15] Robert Harriss, et al., *Using Multi-Scale Measurements to Improve Methane Emissions Estimates from Oil and Gas Operations in the Barnett Shale, Texas: Campaign Summary*, 49 ENVIRON. SCI. TECHNOL. 7524-7526 (July 7, 2015) *available at* http://pubs.acs.org/doi/abs/10.1021/acs.est.5b02305 (providing a summary of the 12 studies that were part of the coordinated campaign).

[16] Daniel Zavala-Araiza, et al., *Toward a Functional Definition of Methane Super-Emitters: Application to Natural Gas Production Sites*, 49 ENVIRON. SCI. TECHNOL. 8167−8174 (July 7, 2015), *available at* http://pubs.acs.org/doi/pdfplus/10.1021/acs.est.5b00133.

[17] David R. Lyon, et al., *Aerial Surveys of Elevated Hydrocarbon Emissions from Oil and Gas Production Sites,* 50 ENVIRON. SCI. TECHNOL. 4877–4886 (Apr. 5, 2016), *available at*

http://pubs.acs.org/doi/abs/10.1021/acs.est.6b00705.

- **Phase I, University of Texas**. This study found that emissions from equipment leaks, pneumatic controllers and chemical injection pumps were each 38%, 63% and 100% higher, respectively, than as estimated in national inventories.[18] This study also found that 5% of the facilities were responsible for 27% of the emissions.[19]
- **Phase II, University of Texas**. Two follow-up studies focused specifically on emissions from pneumatic controllers and liquids unloading activities at wells found similar results.[20] Specifically, the studies found that 19 percent of the pneumatic devices accounted for 95 percent of the emissions from the devices tested, and about 20 percent of the wells with unloading emissions accounted for 65 to 83 percent of those emissions. The average methane emissions per pneumatic controller were 17 percent higher than the average emissions per pneumatic controller in EPA's national greenhouse gas inventory.[21]
- **Gathering and Boosting**. The gathering and processing study found substantial venting from liquids storage tanks at approximately 20 percent of the sampled gathering facilities.[22] Emission rates at these facilities were on average four times higher than rates observed at other facilities and, at some of these sites with substantial emissions, the authors found that company representatives made adjustments resulting in immediate reductions in emissions.
- **Transmission and Storage.** In the study on transmission and storage emissions, the two sites with very significant emissions were both due to leaks or venting at isolation valves.[23] The study also found that leaks were a major source of emissions across sources, concluding that measured emissions are larger than would be estimated by the emission factors used in EPA's reporting program.

These studies demonstrate that emission inventories consistently underestimate actual emissions, which calls into question the adequacy of BLM's DEIS, in particular the emission inventory, cumulative impacts analysis, and modeling. We urge BLM to go back and revisit these sections of the DEIS, taking into consideration the scientific information discussed above.

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[18] David T. Allen, et al., *Measurements of Methane Emissions at Natural Gas Production Sites in the United States*, 44 PROC. NATL. ACAD. 110 (Aug. 19, 2013), *available at* http://www.pnas.org/content/110/44/17768.full

[19] *See* David T. Allen, et al., *Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers*, 49 ENVIRON. SCI. TECHNOL. 633–640 (Dec. 9, 2014) (referencing 2013 Allen study), *available at* http://pubs.acs.org/doi/abs/10.1021/es5040156 (hereinafter "Pneumatic Controllers Study").

[20] David T. Allen, et al., *Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquid Unloadings*, 49 ENVIRON. SCI. TECHNOL. 641–648 (Dec. 9, 2014) *available at* http://pubs.acs.org/doi/abs/10.1021/es504016r.

[21] Pneumatic Controllers Study, 49 ENVIRON. SCI. TECHNOL. at 633–640.

[22] Austin L. Mitchell, et al., *Measurements of Methane Emissions from Natural Gas Gathering Facilities and Processing Plants: Measurement Results*, 49 ENVIRON. SCI. TECHNOL. 3219–3227 (Feb. 10, 2015), available at http://pubs.acs.org/doi/abs/10.1021/es5052809.

[23] R. Subramanian, et al., *Methane Emissions from Natural Gas Compressor Stations in the Transmission and Storage Sector: Measurements and Comparisons with the EPA Greenhouse Gas Reporting Program Protocol,* 49 ENVIRON. SCI. TECHNOL. 3252-3261 (Feb. 10, 2015), *available at* http://pubs.acs.org/doi/abs/10.1021/es5060258.

BLM HAS FAILED TO FULLY CONSIDER ALTERNATIVES THAT WOULD REDUCE AIR EMISSIONS BY REQUIRING OPERATORS TO EMPLOY COST-EFFECTIVE, TECHNICALLY FEASIBLE MEASURES

BLM's consideration of low-emitting alternatives fails to meet NEPA requirements. NEPA, 42 U.S.C. §§ 4321-70, requires federal agencies must "take a 'hard look' at the environmental consequences" of the proposed courses of action.[24] An EIS must "rigorously explore and objectively evaluate" all reasonable alternatives to a proposed action, in order to compare the environmental impacts of all available courses of action.[25] For those alternatives eliminated from detailed study, the EIS must briefly discuss the reasons for their elimination.[26]
BLM's elimination of lower emitting alternatives to the preferred action consisted of a cursory description of such alternatives and BLM's reason for rejecting them. This cursory evaluation fails to comport with legal requirements.

BLM noted, but dismissed, an alternative that would have required operators to use flareless drilling, completion and production practices. BLM eliminated this option on the grounds that this was "not technically feasible, and it is inconsistent with the basic policy objectives for the management of the area."[27] BLM explained that this is not a technically feasible option because the state allows for flaring, and it may not be possible to have pipelines installed prior to completions and to use pipelines in all instances.[28]

BLM's rejection of this alternative and any logical outgrowths of this alternative, such as flaring limits, is contrary to NEPA. Alternatives that fall within the agency's statutory mandate are reasonable and must be considered.[29] Technologies and practices are available to limit flaring, even if not wholly eliminate flaring, and BLM should have considered these. Notably, BLM's current waste prevention rule requires operators to curtail flaring over several years by either routing saleable gas to a pipeline or using onsite gas capture equipment—demonstrating that BLM itself has found these options technically feasible and appropriate for projects on BLM lands. Other jurisdictions contain similar restrictions on flaring.[30] Since BLM has proposed to rescind its waste prevention rule,[31] BLM must go back and include a thorough consideration of an analysis that considers limits on flaring such as those contained in its own rule.

BLM has also failed to give due consideration to an alternative that would have reduced methane emissions, including an alternative that requires operators to implement cost-effective, feasible clean air measures such as quarterly leak inspections. BLM summarily eliminated a proposed alternative from detailed analysis entitled "Greenhouse Gas Reduction Alternative," which proposed carbon neutral processes, on the grounds that the proposed alternative was not

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[24] *Pennaco Energy, Inc. v. U.S. Dep't of Interior*, 377 F.3d 1147, 1150 (10th Cir. 2004).
[25] *New Mexico ex rel. Richardson,* 565 F.3d at 703-04 (citing 40 C.F.R. § 1502.14).
[26] *Id.*
[27] DEIS, Ch. 2.6.5, p. 2-44, lines 16-19.
[28] *Id*. at lines 21-26.
[29] *New Mexico ex rel. Richardson*, 565 F.3d at 709.
[30] 17 C.C.R. § 95665 *et seq.* (allowing flaring only where capture is infeasible).
[31] *Waste Prevention, Production Subject to Royalties, and Resource Conservation; Rescission or Revision of Certain Requirements*, 83 Fed. Reg. at 7924.

technically feasible, without providing any data in support.[32] In doing so, BLM apparantly gave no consideration to available, cost-effective methane mitigation measures such as those suggested by EDF in our scoping comments and contained in ICF International's 2014 report. These include quarterly leak inspections and/or alternative compliance pathways that ensure operators are continuously monitoring for leaks. Quarterly inspections or continuous monitoring are two of the best ways to reduce leaks, including leaks from improperly designed and/or operating facilities and equipment.

Lastly, BLM failed to consider an alternative that could significantly decrease emissions by utilizing zero-emitting technologies. BLM summarily dismissed this alternative, "use of electrical power for production," on the basis that the project is exploratory in nature and therefore the precise location of facilities is still unknown.[33] Regardless of the exact location of a particular facility, BLM does know that the project will occur in a region that is currently home to electrical distrubution lines.[34] The existence of these current lines, and their ability to provide grid electricity to the proposed facilities, should have been considererd. In addition, many zero emitting technologies can be powered by solar energy, which does not require access to a grid nor is dependent on the exact location of a facility. BLM's failure to consider the use of solar power to generate electricity for pneumatic controllers and pumps, as well as other equipment, is a fatal flaw in the analysis that must be corrected.

II. <u>Sage Grouse and Sagebrush</u>

Comments in this section are focused on impacts of the Converse County project to sage grouse and the over 350 other species that rely on resilient, intact sagebrush habitat to survive.

MITIGATION IS ESSENTIAL FOR SAGE GROUSE

Mitigation policies and practices are a key feature of the BLM Approved Resource Management Plan Amendments (ARMPAs), figure prominently in the 2015 FWS Not-Warranted Decision's regulatory adequacy determination for the greater sage grouse, and are essential to address primary threats related to habitat loss and fragmentation due to anthropogenic impacts to the sagebrush ecosystem. In order to avoid further sage grouse population declines and triggering the potential for and Endangered Species Act (ESA) listing, BLM must implement the mitigation practices outlined in the ARMPA.

The 2015 FWS Not-Warranted Decision for the Greater Sage Grouse takes as a fundamental precept that

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[32] DEIS, Ch. 2.6.7, p. 2-44, lines 40-46, and 2-45, lines 1-12.
[33] *Id.* at Ch. 2.6.3, p. 2-44, lines 4-7.
[34] *Id.* at Ch. 2.3.1.3, p. 2-18, lines 35-44.

> all of the [ARMPAs] require that impacts to sage-grouse habitats are mitigated and that compensatory mitigation provides a net conservation gain to the species.[35]

In this statement, FWS highlights three features of effective mitigation that will achieve conservation outcomes: 1) adherence to the mitigation hierarchy; 2) use of compensatory mitigation to offset unavoidable impacts; and 3) achieving a net conservation gain. These three features drive the structure of mitigation policies and practices included in the ARMPAs, and must be fully implemented in order to address the impacts of the Converse County project. Pursuant to its Agreement with the State of Wyoming, U.S. Forest Service, U.S. Natural Resource Conservation Service, and U.S. Fish and Wildlife Service, BLM has previously committed:

> In undertaking management actions, and, consistent with valid existing rights and applicable law, in authorizing third-party actions that result in habitat loss and degradation in [Priority Habitat Management Areas], the [BLM] will require and **ensure mitigation that provides a net conservation gain to the species** including accounting for any uncertainty associated with the effectiveness of such mitigation. **This will be achieved by avoiding, minimizing and compensating for impacts** by applying beneficial mitigation actions. In Wyoming, the [U.S. Fish and Wildlife Service] has found that 'the core area strategy, if implemented by all landowners via regulatory mechanism, would provide adequate protection for sage-grouse and their habitats in the state.' **The BLM will implement actions to achieve the goal of net conservation gain consistent with the Wyoming Strategy (EO 2015-4) that includes 'compensatory mitigation as a strategy that should be used when avoidance and minimization are inadequate to protect Core Population Area Greater sage-grouse**.[36]

In addition to the ARMPA applicable to the Project Area, the BLM and Converse County DEIS comport to comply with the State of Wyoming Sage Grouse Executive Order (EO-2015-4) (SGEO) and Framework for Mitigation, in accordance with a Memorandum of Understanding signed by the BLM and State of Wyoming. The State's Framework in turn reiterates that, in coordination with the BLM, it will comply with the ARMPA to a net benefit standard.[37]

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[35] U.S. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List Greater Sage-Grouse (Centrocercus urophasianus) as an Endangered or Threatened Species; 80 FR 59887, 59881. (Sept. 2015).

[36] Memorandum of Understanding among U.S. Dept. of Interior, Bureau of Land Management, U.S. Dept. of Agriculture, Forest Service, U.S. Dept. of Interior, Fish and Wildlife Service, U.S. Dept. of Agriculture, Natural Resource Conservation Service, and the State of Wyoming, To Promote a Cohesive and Consistent Conservation Strategy for the Greater Sage Grouse and its Habitat in the State of Wyoming (2017)(emphasis added). Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd534481.pdf

[37] State of Wyoming. Revised Greater Sage-grouse Compensatory Mitigation Framework. https://wgfd.wyo.gov/WGFD/media/content/Habitat/20170710-Revised-Habitat-Mitigation-Framework.pdf

AVOIDANCE AND MINIMIZATION OF DISTURBANCE ARE ESSENTIAL FOR SAGE GROUSE

Best available science indicates that preventing a listing of greater sage grouse under the ESA requires landscape-scale conservation measures focused primarily on preventing habitat degradation and fragmentation through avoiding impacts.[38] By maintaining interconnected areas of high-quality habitat, stable populations of sage grouse may be maintained in several locations, increasing the likelihood of long-term survival.[39] Sage grouse are highly sensitive to human disturbance such that small amounts of development can cause disproportionate population declines.[40] Landscape-scale habitat fragmentation resulting from human disturbance has significant direct and indirect impacts on sage grouse because they are particularly vulnerable to noise and encroachment. In addition, habitat fragmentation is also linked to the spread of invasive species (e.g., cheatgrass) known to degrade GRSG habitat.[41] The likelihood of successful restoration of sagebrush habitat through compensatory mitigation after development or the introduction of invasive species is low.[42]

Expert research and recommendations incorporated in the ARMPAs reflect the importance of sagebrush habitat preservation as the foremost strategy for sage grouse conservation. For example, the National Technical Team Report was unequivocal in its recommendation for policies and land use decisions that avoided anthropogenic disturbances to sage grouse habitat.

> Sage-grouse populations have the greatest chance of persisting when landscapes are dominated by sagebrush and natural or human disturbances are minimal (Aldridge et al. 2008, Knick and Hanser 2011, Wisdom et al. 2011). Within priority habitat, a minimum range of 50-70% of the acreage in sagebrush cover is required for long-term sage-grouse persistence (Aldridge et al. 2008, Doherty et al. 2010, Wisdom et al. 2011).
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> …
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> [T]he conservation strategy most likely to meet the objective of maintaining or increasing sage-grouse distribution and abundance is to *exclude* energy development and other large scale

[38] Decker KL, Pocewicz A, Harju S, Holloran M, Fink MM, Toombs TP, et al. Landscape disturbance models consistently explain variation in ecological integrity across large landscapes. Ecosphere. 2017;8: e01775. doi:10.1002/ecs2.1775.

[39] Greater Sage-Grouse (Centrocercus urophasianus) Conservation Objectives: Final Report [Internet]. Denver, CO; (2013). Available at: http://www.ncbi.nlm.nih.gov/pubmed/5784470.

[40] Edited by Steven T. Knick and John W. Connelly. Greater Sage-grouse: Ecology and Conservation of a Landscape Species and its Habitats [Internet]. 1st ed. The Wilson Journal of Ornithology. University of California Press; 2011. doi:10.1525/j.ctt1ppq0j.

[41] Connelly JW, Knick ST, Schroeder MA, Stiver SJ. Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats. Proc West Assoc Fish Wildl Agencies. 2004; 610. Available: http://digitalcommons.usu.edu/govdocs

[42] Shaw NL, Debolt AM, Rosentreter R. Reseeding big sagebrush: techniques and issues. USDA For Serv Proc. 2005; 99–108; Crawford JA, Olson RA, West NE, Mosley JC, Schroeder MA, Whitson TD, et al. Ecology and management of sage-grouse and sage-grouse habitat. J Range Manag. 2004;57: 2–19. doi:10.2111/1551-5028(2004)057[0002:EAMOSA]2.0.CO;2.

> disturbances from priority habitats, and where valid existing rights exist, minimize those impacts by keeping disturbances to 1 per section with direct surface disturbance impacts held to 3% of the area or less.[43]

The Conservation Objective Team (COT), composed of state and federal experts, also recommended an “avoidance first strategy” to preserve unadulterated, intact sagebrush habitat.[44] An avoidance first strategy, as described by the COT, means that avoidance and minimization measures such as withdrawal of sagebrush focal areas, eliminating development within priority areas, establishing lek buffers, closing land to OHVs, and fire suppression must continue to be emphasized.

The FWS specifically reflected these science-based recommendations, and reinforced the importance of following the mitigation hierarchy, and particularly the first step – avoidance – in its review of the Federal Plans. While mitigation may not be effective in landscape-scale management, avoidance is not only effective, but has been described as critical to GRSG recovery in the 2015 FWS Not-Warranted Decision. It states,

> if impacts from BLM/USFS management actions and authorized third party actions that result in habitat loss and degradation remain **after applying avoidance and minimization measures** (i.e. residual impacts), then compensatory mitigation will be used.[45]

The 2015 FWS Not-Warranted Decision highlights anthropogenic disturbance as a significant and continuing threat to sage grouse, and describes the disturbance caps included in the ARMPAs as a means to minimize that threat. While the disturbance caps included in the ARMPAs provide important protective benefits to sage grouse populations and habitat, best available science indicates that at a minimum disturbance caps must not be diluted, and in fact could be enhanced to accommodate both direct and indirect effects on greater sage grouse.
According to the 2015 FWS Not-Warranted Decision,

> Each [ARMPA] includes a disturbance cap that will serve as an upper limit (the maximum disturbance permitted). To limit new anthropogenic disturbance within sage-grouse habitats, the Federal Plans establish disturbance caps, above which no new development is permitted. This cap acts as a backdrop to ensure that any

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[43] U.S. Department of Interior, Bureau of Land Management, National Technical Team, National Greater Sage-Grouse Conservation Measures/Planning Strategy, p. 20 (Discussing past BLM conservation measures including 0.25 mile NSO lek buffers and timing stipulations applied to 0.6 miles around leks) (Dec. 21, 2011) (emphasis added) (https://eplanning.blm.gov/epl-front-office/projects/lup/9153/39961/41912/WySG_Tech-Team-Report-Conservation-Measure_2011.pdf

[44] Greater Sage-Grouse (Centrocercus urophasianus) Conservation Objectives: Final Report [Internet]. Denver, CO; 2013. Available: http://www.ncbi.nlm.nih.gov/pubmed/5784470.

[45] U.S. Fish and Wildlife Service. Endangered and Threatend Wildlife and Plants; 12-Month Finding on a Petition to List Greater Sage-Grouse (Centrocercus urophasianus) as an Endangered or Threatened Species 80 FR 59887. (Sept. 2015)(emphasis added).

> implementation decisions made under Federal Plans will not permit substantial amounts of new disturbances within the distribution of sage-grouse on BLM and USFS lands.[46]

Sage grouse are impacted by direct *and* indirect effects of human disturbance.[47] Direct effects are immediate impacts that eliminate habitat of reduce habitat quality such that it is unusable to GRSG.[48] Examples of direct impacts include the footprint of a road or well pad where all vegetation has been removed and replaced with pavement or structures. Indirect impacts are negative effects on habitat quality that are caused by the disturbance, but that extend beyond the footprint of the direct impact (e.g. noise, nest predators, human activity). Sage grouse may avoid using otherwise suitable habitat because of indirect impacts, such as noise from vehicles using roads.[49]

Disturbance cap thresholds are generally supported by the scientific literature showing that cumulative effects of anthropogenic activity have a negative effect on sage grouse populations (as measured through effects on leks).[50,51] Due to the clear negative relationship between anthropogenic activity and sage grouse populations, no scientific literature supports thresholds higher than those included in the ARMPAs.

The 2015 FWS Not-Warranted Decision evaluated disturbance caps at scales of both the Biologically Significant Unit and the Priority Habitat Management Area, as established in the ARMPAs. In order to be maximally effective, best available science indicates that disturbance

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[46] U.S. Fish and Wildlife Service. Endangered and Threatend Wildlife and Plants; 12-Month Finding on a Petition to List Greater Sage-Grouse (Centrocercus urophasianus) as an Endangered or Threatened Species 80 FR 59887 (Sept. 2015).

[47] D. J. Manier, Z. H. Bowen, M. L. Brooks, M. L. Casazza, P. S. Coates, P. A. Deibert, S. E. Hanser, and D. H. Johnson, "Conservation buffer distance estimates for Greater Sage-Grouse: a review," Reston, VA, 2014.; M. J. Wisdom, C. W. Meinke, S. T. Knick, and M. A. Schroeder, "Factors associated with extirpation of sage-grouse," *Gt. Sage-Grouse Ecol. Conserv. a Landsc. Species Its Habitats*, vol. 38, pp. 451–472, 2011; J. L. Blickley, D. Blackwood, G. L. Patricelli, and J. Blickley, "Experimental Evidence for the Effects of Chronic Anthropogenic Noise on Abundance of Greater Sage-Grouse at Leks," *Conserv. Biol.*, vol. 26, no. 3, pp. 461–471; M. R. Dzialak, S. L. Webb, S. M. Harju, C. V Olson, J. B. Winstead, L. D. Hayden, and L. D. Hayden-Wing, "Greater Sage-Grouse and Severe Winter Conditions: Identifying Habitat for Conservation," *Rangel. Ecol. Manag. Rangel. Ecol Manag.*, vol. 66, no. 66, pp. 10–1810, 2013.

[48] M. R. Dzialak, S. L. Webb, S. M. Harju, C. V Olson, J. B. Winstead, L. D. Hayden, and L. D. Hayden-Wing, "Greater Sage-Grouse and Severe Winter Conditions: Identifying Habitat for Conservation," *Rangel. Ecol. Manag. Rangel. Ecol Manag.*, vol. 66, no. 66, pp. 10–1810, 2013; R. S. Gamo and J. L. Beck, "Erratum to: Effectiveness of Wyoming's Sage-Grouse Core Areas: Influences on Energy Development and Male Lek Attendance," *Environmental Management*, vol. 59, no. 4. p. 708, 2017.

[49] M. J. Holloran, "Greater sage-grouse (Centrocercus urophasianus) population response to natural gas field development in Western Wyoming," 2005.

[50] C. P. Kirol, "Quantifying habitat importance for greater sage-grouse (Centrocercus urophasianus) population persistence in an energy development landscape," University of Wyoming, 2012.

[51] S. T. Knick, S. E. Hanser, and K. L. Preston, "Modeling ecological minimum requirements for distribution of greater sage-grouse leks: Implications for population connectivity across their western range, U.S.A," *Ecol. Evol.*, vol. 3, no. 6, pp. 1539–1551, 2013.

caps must be accompanied by strict density limits to accommodate known direct and indirect impacts associated with development. [52]

However, the Converse County DEIS clearly indicates that disturbance thresholds will be exceeded as "existing disturbance within the DDCT assessment areas already exceeds the five percent disturbance cap for four of the five assessment areas as stipulated in WY EO 2015-4, the Approved Resource Management Plan Amendment for the Wyoming Greater Sage-grouse Sub-region (Attachment 4 to BLM 2015b), and the Land Management Plan Amendment for TBNG (Attachment B to USFS 2015b)."[53] This is inconsistent with the ARMPAs, standing agreements with the State of Wyoming and other federal land management agencies, and inconsistent with the best available science relied upon in the 2015 FWS Not Warranted Decision.

COMPENSATORY MITIGATION IS NOT A REPLACEMENT FOR AVOIDANCE AND MINIMIZATION

Due to the unequivocally critical importance of intact, un-impacted sagebrush habitat to sage grouse survival, the weakening of the restrictions set forth in the ARMPA and SGEO that require avoidance of key sage grouse habitat must be resisted.
This applies to disturbance thresholds as well as restrictions on disturbance during the breeding season. Greater sage grouse are vulnerable to a wide range of human disturbances, particularly when they are associated with breeding. The birds engage in mating behavior involving a communal courtship area, known as a lek, in which males of the species compete through calls and displays for females. Excessive noise, or close proximity to human structures or activities, can lead to reduced breeding success, and more often than not, total abandonment of breeding for that year.[54]

To address these issues, the Converse County DEIS incorporates buffers of various distances around sage grouse leks and nesting sites as well as restrictions on activity during the breeding, nesting, and early brood rearing season in compliance with the BLM ARMPA and the USFS Land Management Plan Amendments. The DEIS identifies the following avoidance measures for "sage grouse, leks, core areas, nesting, early brood-rearing, wintering habitats, PHMAs, and GHMAs":

- NSO or no surface disturbing activities on or within a 0.6 mile radius of the perimeter of 13 occupied sage-grouse leks

[52] J. W. Connelly, S. T. Knick, M. A. Schroeder, and S. J. Stiver, "Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats," *Proc. West. Assoc. Fish Wildl. Agencies*, no. June, p. 610, 2004.
[53] Impacts to Greater Sage-grouse PHMAs. 4.18-62. 4.18 – Wildlife and Aquatic Biological Resources. Converse County Draft EIS.
[54] Monroe AP, Aldridge CL, Assal TJ, Veblen KE, Pyke DA, Casazza ML. Patterns in Greater Sage-grouse population dynamics correspond with public grazing records at broad scales. Ecol Appl. 2017;27: 1096–1107. doi:10.1002/eap.1512; Greater Sage-Grouse (Centrocercus urophasianus) Conservation Objectives: Final Report [Internet]. Denver, CO; 2013. Available: http://www.ncbi.nlm.nih.gov/pubmed/5784470; Walker BL, Naugle DE, Doherty KE. Greater sage-grouse population response to energy development and habitat loss. J Wildl Manage. 2007;71: 2644–2654. doi:10.2193/2006-529.

- No surface disturbing and/or disruptive activities within PHMA from March 15 to June 30 to 15 protect sage-grouse breeding, nesting, and early brood rearing habitat
- No surface disturbing and/or disruptive activities within PHMAs (connectivity only) from 17 March 15 to June 30 to protect breeding, nesting, and early brood-rearing habitats within
- 4 miles of the lek or lek perimeter of any occupied sage-grouse lek
- No surface disturbing and/or disruptive activities from March 15 to June 30 to protect sage grouse nesting and early brood rearing habitats within 2 miles of the lek or lek perimeter of any occupied lek located outside PHMAs
- NSO within 0.25 mile of occupied leks. Avoid human activity between 8 PM and 8 AM from March 1 to May 15 within GHMAs
- Avoid surface disturbing activities in suitable nesting and early brood rearing habitats within 25 2 miles of occupied leks or in identified nesting and brood rearing habitats outside of the 26 2-mile buffer from March 15 to July 15 within GHMAs
- Construction of new oil and gas development is prohibited within 0.25 mile of display grounds within GHMAs
- No construction or drilling within 2 miles of active display grounds from March 1 to June 15 30 within GHMAs
- Limit new noise levels to 10 dBA above ambient noise (existing activity included) measured 32 at the perimeter of a lek from 6 PM to 8 AM from March 1 to May 15
- Avoid surface disturbance in winter concentration areas from December 1 to March 15[55]

However, the Converse County DEIS also states:

> If residual impacts affect the ability to comply with laws, regulations, policies, and/or land use plan objectives, compensatory mitigation would be warranted to offset the impact(s). This category would apply to the request for exceptions to timing limitation stipulations under Alternative B.[56]

This is illogical. Timing limitation stipulations are imposed to avoid seasonal impacts to sage grouse and leks during critical life-cycle periods, such as breeding. Impacts caused during those critical life-cycle periods cannot be mitigated; lower male lek attendance, lek avoidance and other impacts will result in localized population declines. The addition or rehabilitation of habitat elsewhere, at a different time, cannot mitigate these impacts. Moreover, if allowed to occur, these impacts are likely irreversible.[57] BLM failed to demonstrate how compensatory mitigation could minimize the impacts associated with exceptions to timing limitations. Due to these serious and potentially irreversible impacts, and BLM's failure to identify reliable opportunities to minimize these impacts, exemption to timing limitations should not be granted.

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[55] 6.2.1 Avoidance. Converse County DEIS. Volume II Chapter 6. Mitigation Strategies.

[56] 6.2.5.1. Laws, Regulations, Policies, and Land Use Plan Objectives. Converse County DEIS. Converse County DEIS. Volume II Chapter 6. Mitigation Strategies.

[57] Holloran, M. J., and S. H. Anderson. 2005. Spatial distribution of greater sage-grouse nests in relatively contiguous sagebrush habitats. Condor 107:742-752.
Holloran, M. J., R. C. Kaiser, and W. A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management 74:65-72.

And with regards to disturbance thresholds, the DEIS states: "According to Wyoming EO 2015-4, any lek with greater than 11 well pads within a 2-mile radius would be in exceedance of the disturbance cap, which restricts more than 1 well pad and associated infrastructure per 640 acres, on average. Assuming an even distribution of well pads, development under Alternative B would exceed this level of development for 38 of the 46 sage-grouse leks within 2 miles of the CCPA."[58] To address this, the DEIS proposes: "because the PHMAs (as mapped in Core Area Version 3) are already well above the 5 percent disturbance threshold, compensatory mitigation applied to the PHMAs must be considered for Alternative B to achieve a net conservation gain."[59]

This is clearly a misapplication of compensatory mitigation. BLM is required to comply with applicable laws, regulations, policies and land use plan objectives, not "mitigate" around them. BLM mitigation policy clearly states: "BLM policy is to mitigate impacts to an acceptable level onsite whenever possible through avoidance, minimization, remediation, or reduction of impacts over time. Offsite mitigation is not to become the default resource mitigation practice for projects permitted by the BLM."[60]

The protections provided particularly to priority and general habitat management areas are essential to long-term viability of sage grouse populations; the bird cannot avoid significant further population decline without them. The disturbance and timing restrictions set forth in Wyoming SGEO 2015-5 and the ARMPA were clearly intended to avoid and minimize impacts to sage grouse. The combined goal of the ARMPA and USFS plans cited in the DEIS are to "protect PHMAs and GHMAs from anthropogenic disturbance that will reduce distribution or abundance of greater sage-grouse."[61] Similarly, the Wyoming SGEO Mitigation Framework unequivocally states as the intent: "The primary emphasis of the Wyoming GSG conservation strategy is to avoid and minimize impacts to the species first. Since the inception of Wyoming's strategy, those efforts have been employed across the state, and have been effective in avoiding and reducing impacts and threats to the species."[62]

Allowing blanket use of compensatory mitigation as a loophole to the disturbance caps and seasonal timing requirements in the EO and ARMPA as proposed for Alternative B is clearly not copacetic with the intent of the ARMPA or SGEO, and is not compatible with healthy sage grouse populations.

THE PROJECT WILL CAUSE SEVERE IMPACTS TO WILDLIFE

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[58] 4.18-63. Impacts to Greater Sage Grouse Leks and Breeding Habitats. Converse County DEIS. Volume II Chapter 4.

[59] 6.6.2.2 Wildlife. Converse County DEIS. Volume II Chapter 6. Mitigation.

[60] BLM. Offsite Mitigation. Instruction Memorandum 2008-204. 30 Sept 2008. https://www.blm.gov/policy/im-2008-204

[61] 6.3.3 Combined Goals and Objectives from the BLM Record of Decision and Approved Resource Management Plan Amendment and the USFS Greater Sage-grouse Record of Decision and Land Management Plan Amendment. Converse County DEIS. Volume II Chapter 6. Mitigation.

[62] State of Wyoming. Revised Greater Sage-grouse Compensatory Mitigation Framework. https://wgfd.wyo.gov/WGFD/media/content/Habitat/20170710-Revised-Habitat-Mitigation-Framework.pdf

The Converse County project clearly will have significant impacts to wildlife resources. Table 2.7-2 compares wildlife impacts by resources for all alternatives:[63]

Resource	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C	Additional Discussion
Mule Deer Year-long	7,661	39,354	27,847	-
Mule Deer Winter/Year-long	2,556	13,128	9,290	-
White-tailed Deer Winter/Year-long	13	67	48	-
Elk Year-long	269	1,380	976	-
Federally Listed Species Habitat (estimated incremental acres disturbed)				Section 4.18; **Appendix F**
Preble's meadow jumping mouse	31	158	112	-
Black-footed ferret	108	555	393	-
Greater Sage-grouse Habitat (estimated incremental acres disturbed)				Section 4.18; **Appendix F**
PHMA	2,176	11,177	7,279	-
2.0 Mile Lek Buffer	810	4,158	2,942	-
Sagebrush Shrubland Habitat	2,254	11,584	8,197	-

[1] There are no lands classified as SIO High with the CCPA.

Resource	Alternative A (No Action)	Alternative B (Proposed Action)	Alternative C	Additional Discussion
Developed	70	362	256	-
Wetland/riparian	75	383	272	-
Mixed shrubland	51	260	184	-
Federally Listed Species Habitat (estimated incremental acres disturbed)				
Ute ladies' tresses orchid	41	211	149	Section 4.14; **Appendix E**
Visual Resources				
Visual Resource Management (VRM) Class II areas on BLM Lands (incremental acres disturbed)	49	254	180	Section 4.15
Scenic Integrity Objective (SIO) Moderate Class on USFS Lands (incremental acres disturbed)[1]	24	124	88	Section 4.15
Water Resources				
Total Water Use (acre-feet/year)	1,500	7,000	4,200	Section 4.16; **Appendix E**
Wastewater Disposal (acre-feet per year)				Section 4.16; **Appendix E**
Flowback	858	3,870	1,935	-
Produced Water	1,980	5,880	2,940	-
Total Wastewater to be disposed	2,838	9,750	4,875	-
Wildlife Resources				
WGFD Strategic Habitat (estimated incremental acres disturbed)				Section 4.18
Douglas Crucial Habitat Area	177	910	644	-
Ormsby Crucial Habitat Area	1,441	7,402	5,238	-
Thunder Basin Crucial Habitat Area	2,213	11,366	8,043	-
Thunder Basin Enhancement Area	1,857	9,537	6,749	-
Big Game Ranges (estimated incremental acres disturbed)				Section 4.18
Pronghorn Year-long	7,329	37,648	26,640	-
Pronghorn Winter/Year-long	2,781	14,288	10,110	-
Pronghorn Severe Winter Relief	44	228	161	-

BLMs own analysis reveals that all alternatives will have considerable impacts for wildlife resources; however, Alternative B is clearly the most impactful.

The DEIS discloses severe impacts to sage-grouse that include the following:

> Residual Impacts – Alternative B. Specific to sage-grouse, despite the implementation of the mitigation measures above, based on the recent downward trend in peak male attendance, all sage-grouse leks in the CCPA would be at risk of being abandoned as

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[63]Table 2.7-2. Impact Comparison By Resource for All Alternatives. Converse County DEIS. Volume 1 Chapter 2. Proposed Action and Alternatives; p 2-53, 2-54. Available at: https://eplanning.blm.gov/epl-front-office/projects/nepa/66551/131874/160926/03_Converse_County_DEIS_Vol_I_Chapter_2_0_Proposed_Action.pdf.

> development would continue to increase in surrounding areas under Alternative B. As described above, habitat selection by sage-grouse is very specific. The potential for granting of exceptions to timing limit stipulations would increase impacts to sage-grouse and associated habitat as a result of disturbance by noise and human presence. Despite NSO stipulations around lek sites, by granting exceptions to timing limitations within sensitive sage grouse habitat, development activity could disrupt activity during sensitive time periods and prohibit use of associated habitats or cause relocation to less desirable habitat. As a result, there would be a reduction in the use of nesting habitat, lower reproductive success including lower brood survival, and a loss of foraging habitat.[64] Impacts to Special Status Wildlife Species from Alternative C. As discussed under Alternative A and shown on Table 4.18-21, the 54 leks within the CCPA and the 2- mile buffer around the CCPA have experienced reduction in peak male attendance and the average peak male attendance from 2006 to 2016. Similar to Alternatives A and B, based on the recent downward trend in peak male attendance, all sage-grouse leks in the CCPA would be at risk of being abandoned as development would continue to increase in surrounding areas under Alternative C.[65]

This analysis clearly suggests that Alternative B's proposed use of compensatory mitigation as a way to avoid timing restrictions as required by the ARMPA and SGEO will have clear consequences for the sage grouse. However, it also suggests that even Alternative C – which would all implement management direction or requirements from the BLM Casper RMP (BLM 2007b) and USFS TBNG LRMP (USFS 2001) to minimize impacts to all wildlife species – will have significant impacts to the sage grouse because of the vulnerability of this population. These impacts are clearly inconsistent with the intent of the ARMPA and SGEO to conserve sage grouse.

EXPERT ANALYSIS

For further discussion of the analysis in the DEIS and the impacts to sage grouse, please see Attachment A, *Draft Environmental Impact Statement for Converse County Oil and Gas Project (January 2018):*

A technical and scientific assessment of the greater sage-grouse relevant portions of the document, authored by Dr. Matt Holloran. EDF incorporates and fully adopts his comments and recommendations. Dr. Holloran identified several fundamental errors in the DEIS analysis, including:

- The DEIS erroneously focuses on infrastructure density to assess the impacts of well pads on sage grouse, ignoring other factors that also influence lek occupancy by males such as distance to infrastructure and configuration of infrastructure around leks.

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[64] 4.18.3.4. Residual Impacts – Alternative B. Converse County DEIS. Volume 11 Chapter 4. Environmental Consequences.

[65] 4.18.3.5. Impacts to Special Status Wildlife Species from Alternative C. Converse County DEIS. Volume 11 Chapter 4. Environmental Consequences (emphasis added).

- The DEIS incorrectly relies on metrics from the Wyoming SGEO to assess landscape-scale disturbance, whereas the Wyoming SGEO metrics are site specific and not applicable to scenarios in which disturbance thresholds are exceeded, as they are in proposed Alternatives. To remedy this deficiency, BLM should incorporate metrics that will better assess large-scale impacts, such as fragmentation statistics, habitat patch size and juxtaposition, and connectivity.
- The DEIS neither appropriately assessed impacts associated with roads, nor identified appropriate mitigation for the significant impacts associated with daily truck traffic in close proximity to leks, key habitat.
- The DEIS failed to evaluate long-term impacts of cheatgrass introduction and proliferation, and the potential for indefinite elimination of sage grouse habitat and drier Wyoming big sagebrush sites due to Project development.
- The DEIS did not reflect the science-based reality that impacts associated with Project development are widespread and irreversible. Particularly, where BLM states that "all the leks in the Project Area would be at risk of being abandoned"[66] as a result of development, BLM failed to acknowledge that lek abandonment and associated population declines are not reversible.
- Due to established differences between small-scale, localized population trends and landscape-scale population trends, and the fact that sage grouse rely on a diverse suite of resources on an annual and seasonal basis that must be considered holistically, BLMs consideration of cumulative impacts is insufficient. The DEIS proposal to evaluate cumulative impacts at the APD stage will create a situation in which cumulative impacts of development may not be realized until adverse effects have already occurred.

THE CONVERSE COUNTY PROJECT NECESSITATES COMPENSATORY MITIGATION

Each of the Alternatives described in the DEIS will clearly impact sage grouse and other resources as outlined above and in the DEIS in Section 4.18 – Wildlife and Aquatic Resources. As described, the project will have residual impacts that merit compensatory mitigation to a net benefit standard in compliance with the ARMPA. As reiterated in the DEIS:

> The Record of Decision and Approved RMP Amendment (BLM 2015b) states that when authorizing third-party actions that would result in greater sage-grouse habitat loss and degradation, the BLM would require and ensure mitigation that would provide a net conservation gain to the species (i.e., the actual benefit or gain above baseline conditions).[67]

For the preferred alternative (Alternative B), the DEIS analysis identifies the following residual impacts:

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[66] 4.18-72. Wildlife and Aquatic Biological Resources. Converse County DEIS. Volume II Chapter 4. Environmental Consequences.

[67] 6.6.2.2. Wildlife. Converse County DEIS. Volume II Chapter 6. Mitigation.

> Alternative B would result in impacts to special status wildlife species associated with surface disturbance, habitat fragmentation, human disturbance, and the potential for granting of exceptions to timing limit stipulations.
> Compensatory mitigation would be warranted for greater sage-grouse because avoidance and minimization of residual impacts to the species and its habitat may be inadequate or impossible based on the amount of existing disturbance within PHMA. This concept of utilizing compensatory mitigation is based on EO 2015-4 and the BLM and USFS complementary strategy for which, subject to valid existing rights and consistent with applicable law, land management agencies require mitigation that provides a no net loss or a net conservation gain to the species, including accounting for any uncertainty associated with the effectiveness of such mitigation.[68]

We question whether enough will be done to avoid and minimize impacts to wildlife as, in BLM's own admission, each of the alternatives would lead to loss of multiple leks or even the extirpation of the sage grouse – and potentially other species – from the project area. However, we commend BLM for recognizing the need for compensatory mitigation to offset severe impacts to species to a standard of net conservation gain.

We urge the BLM to clearly define the residual impacts for which compensatory mitigation will be required now for the project in its entirety, and not wait to assign mitigation on a case-by-case basis. We expect this mitigation to cover the residual impacts of the project as identified by the BLM. We also recommend the BLM approve development to proceed on a phased basis, using monitoring and adaptive management to ensure that the impacts of the project on wildlife resources are as expected and that mitigation efforts have been successful in ameliorating impacts.

III. RECOMMENDATIONS

In summation and conclusion, we urge the BLM to:

- Provide full consideration of cleaner alternatives, including an alternative that would require operators to use cost-effective, feasible measures to reduce emissions such as a quarterly leak detection and repair provision, and re-issue the DEIS after rigorously exploring and objectively evaluating cleaner alternatives as required by NEPA.
- Revisit the air quality assumptions of the DEIS, taking into consideration the scientific information discussed above. These studies demonstrate that emission inventories consistently underestimate actual emissions, which calls into question the adequacy of BLM's DEIS, in particular the emission inventory, cumulative impacts analysis, and modeling.
- Reconsider lower emitting alternatives to the preferred action. BLM's analysis in this proposal consisted only of a cursory description of such alternatives and BLM's reason for rejecting them. This cursory evaluation fails to comport with legal requirements.

[68] 4.18.3.4. Residual Impacts – Alternative B. Converse County DEIS. Volume 11 Chapter 4. Environmental Consequences.

- Ensure the Converse County development proceeds in the least impactful way possible to sage grouse, choosing Alternative C as a minimum, and evaluating additional measures such as phased development and the use of monitoring and adaptive management to ensure the impacts and mitigation measures associated with the project are as expected;
- Avoid and minimize project impacts to wildlife to the extent possible, and do not allow development that proceeds in conflict with the ARMPA and SGEO;
- Use compensatory mitigation as appropriate: where avoidance and minimization have been used to the fullest extent possible, but residual impacts still remain. Compensatory mitigation is not a replacement for avoidance and minimization measures such as disturbance thresholds and seasonal timing restrictions;
- Clearly define the residual impacts for which compensatory mitigation will be required now for the project in its entirety in the Final EIS and Record of Decision, and not wait to assign mitigation on a case-by-case basis.

Thank you for considering these comments.

Sincerely,

Dan Grossman
EDF Rocky Mountain Regional Director

Attachment A

Draft Environmental Impact Statement for Converse County Oil and Gas Project (January 2018)
A technical and scientific assessment of the greater sage-grouse relevant portions of the document
Matt Holloran
03/09/2018

In order to achieve sage-grouse conservation goals, the BLM and USFS must manage sage-grouse habitats at landscape spatial scales. This need is explicitly established in the ARMPA (pg. 23) where the overriding management goal is to "conserve, restore and enhance sage-grouse habitat on a landscape scale…" One of the primary objectives of developing Environmental Impact Statements (EIS) is to provide analyses "adequate for the purpose of reaching informed decisions regarding Project development" (Draft EIS for Converse County Oil and Gas Project [DEIS]; pg. 1-2). In the context of landscape-scale conservation, informed decision-making requires empirically-based impact assessments done across relevant scales. The following is an assessment of the qualitative and deductive analyses and resulting conclusions for greater sage-grouse (sage-grouse) presented in the DEIS. I provide evaluations of analyses pursued, suggestions for adjustments to analyses, and point out where the analyses could contribute to inaccurate conclusions given the framework of landscape-scale conservation. Although my assessment focuses on the analyses estimating risk of impact of proceeding with Alternative B, the same concerns generally track with Alternative C especially in the context of estimating likely residual impacts in the context of adhering to stipulations (i.e., avoidance and minimization) as is generally the case for Alternative C.

The qualitative analyses used to estimate the potential impact of infrastructure on sage-grouse included an assessment of: (1) the change in infrastructure density within 2 miles of known sage-grouse leks occurring in the Project area; (2) the change in the amount of surface disturbance as a percentage of DDCT assessment areas established in core habitats associated with the Project area; and (3) the change in the level of fragmentation as a change in linear Project components per square mile.

Infrastructure Density:--Assuming a uniform distribution of infrastructure throughout the Project area, it was estimated that each lek (on average) would have 9.9 additional well pads placed within 2 miles under Alternative B (pg. 4.18-63). These estimates were added to the number of existing well pads within the 2-mile buffers, and infrastructure density estimates presented in Doherty et al. (2010) were used to categorically establish that 31 leks (58%) in the Project area would be "moderately" impacted as a result of pursuing Alternative B (pg. 4.18-63). These results led to the conclusion in the DEIS that "development under Alternative B would exceed [the 1 well pad per square mile threshold] of development for 38 of the 46 sage-grouse leks within 2 miles of the [Project area]" (pg. 4.18-63). Although the numbers cited in this sentence do not track from the information provided in this section of the DEIS, the line of reasoning presented suggests that 58 to 83% of the leks in the Project area would be at risk of being abandoned as a result of increased infrastructure densities within 2 miles (see Holloran 2005, Doherty et al. 2010). However, based on the information provided in Doherty et al. (2010; Table 1), more specific estimates of potential impact could have been generated from the analyses presented.

For example, given the estimate of 9.9 additional wells within 2 miles of each lek, the probability of lek abandonment will double for 31 of the 52 leks (60%) listed in Table 4.18-21 (pg. 4.18-51), suggesting that up to 16 of those 31 leks would be abandoned. Combining this result with the "resulting decline in active leks" estimate (-11.5%) provided in Doherty et al. (2010; Table 1) suggests that approximately 4 of those 31 leks would be abandoned, providing a more accurate estimate of 4 to 16 of the 31 leks where the development threshold has been exceeded would become inactive as a result of pursuing Alternative B. Further, based on the lek count information provided in Table 4.18-21 (pg. 4.18-51) and "decline in males on remaining active leks" estimate (-31.4%) provided in Doherty et al. (2010; Table 1), the estimated decline in the total population as a result of pursuing Alternative B would be approximately 20%. This was estimated by establishing the proportion of the total counted population associated with leks where it was predicted that infrastructure densities would surpass the threshold, and multiplying that estimate by -31.4%. This provides a relative and additive estimate of population declines expected (i.e., the population <u>on all leks that remain active following development</u> will decline by an estimated 20%). This admittedly preliminary assessment of impact provides a more tangible goal for developing compensatory mitigation needs (see pg. 4.18-72), discussed in more detail below.

The approach taken in the DEIS of assessing the impact of well pads (as well as my suggested modifications to those estimates) focuses on infrastructure density, but research suggests that the distance from leks to infrastructure, as well as the configuration of infrastructure surrounding leks influence the number of males occupying those leks. Several authors have reported a distance-effect associated with the infrastructure of energy fields whereby sage-grouse are negatively influenced to a greater extent if infrastructure is placed near seasonal habitat with the response diminishing as distances from the habitat to infrastructure increase (Manier et al. 2013). The majority of the research has investigated the response of lekking sage-grouse to energy development, with studies consistently reporting impacts from infrastructure on the number of males occupying leks to approximately 2 miles, with lesser impacts consistently apparent to approximately 4 miles (Holloran 2005, Walker et al. 2007, Tack 2009, Harju et al. 2010, Johnson et al. 2011). Additionally, distance-effects of infrastructure associated with energy developments of between approximately 0.9 and 1.7 miles on average have been noted during nesting, brood-rearing, and winter (Doherty et al. 2008, Carpenter et al. 2010, Holloran et al. 2010, Dzialak et al. 2011, LeBeau 2012, Dinkins 2013, Fedy et al. 2014). Research also suggests that the spatial configuration of infrastructure within landscapes surrounding leks influences male numbers, with leks where wells were clustered in a way that maintained open areas and where infrastructure did not surround the lek having a higher likelihood of remaining active (Holloran 2005, Doherty et al. 2010). Further, changes in the number of males occupying leks situated east (generally downwind) of infrastructure were more negative than those witnessed on leks west of infrastructure (Holloran 2005). These results suggest that increased noise intensity at leks may negatively influence male lek attendance, which is supported by experimental information establishing that sage-grouse avoid leks in response to anthropogenic noise, with intermittent noise (e.g., vehicle traffic) having a greater effect on attendance than continuous noise (e.g., drilling rig; Blickley et al. 2012). These additional considerations suggest that impact estimates resulting from an assessment of changes in infrastructure density within 2 miles of leks should be considered minimums.

Surface Disturbance:--Surface disturbance impacts were established as an estimate of the proportional increase in surface disturbance within DDCT assessment areas established essentially at the scale of core areas located within the Project area (see Figure 4.18-1; pg. 4.18-49). These analyses led to the conclusion that the 5% surface disturbance cap was exceeded in 3 of the 5 core areas situated within the Project area. However, under Alternative B, "development could be approved on a site-specific basis consistent with the DDCT process if found to be under the 5 percent cap" (pg. 4.18-63). This conclusion is correct, and points to the concern with the approach used to estimate impact: the metrics and thresholds established in Wyoming's sage-grouse management plan (WY SGEO 2015-4) are site-specific, and are not applicable for assessing sage-grouse habitat conditions at larger spatial scales (e.g., the scale of a core area or a Biologically Significant Unit [BSU]). Thus, the DEIS cannot rely solely on the metrics included in the State's approach (i.e., surface disturbance and infrastructure density) when investigating the potential impacts of a proposed development at larger spatial scales. Additional assessment metrics that can be used to effectively establish the conditions of sage-grouse habitats at these larger scales (e.g., fragmentation statistics; habitat patch size and juxtaposition; connectivity; etc.; Wisdom et al. 2011, Knick et al. 2013, Burkhalter et al. 2018) are worth considering. Also worth noting is that the site-specific metrics developed by the State of Wyoming are relevant only in the situation where management adheres to threshold values (Holloran 2005; Doherty et al. 2010). To be useful in the situation where those thresholds are surpassed, the use of those metrics needs to be modified to account for incremental impacts to sage-grouse populations at infrastructure levels higher than the thresholds (Decker et al. 2017).

Fragmentation:--Again assuming a uniform distribution of infrastructure throughout the Project area, it was estimated that the average length of linear features (used as a proxy for fragmentation in the DEIS) would increase from 1.9 mi/mi^2 of roads, pipelines, and overhead power lines to 3.72 mi/mi^2 in the Project area under Alternative B (pg. 4.18-65). The increase in linear features was not tied to sage-grouse populations in the DEIS. Based on information provided in Knick et al. (2013), most active leks in western portions of the sage-grouse range were in areas with less than 1.6 mi/mi^2 of secondary roads and less than 0.1 mi/mi^2 of overhead power lines. Using information provided by Tack (2009), an estimated 2-fold decrease in the probability of a large lek (>25 males) when road densities increased from 2 to 4 mi/mi^2 would be expected; at 4 mi/mi^2 of road, the probability of a large lek was approximately 18%. Further, "new roads would be constructed and maintained to provide year-round access" (pg. 2-26) and estimates of traffic volumes (pg. 2-33) suggest >4,000 truck trips/day during a majority of the time the field would be in development and production. This suggests that impacts of development would not be isolated to the breeding season (i.e., all seasonal habitats including winter habitats will be impacted by the development). Research indicates that sage-grouse are avoiding human activity (e.g., truck trips) at the time that activity is experienced (Dzialak et al. 2012, Holloran et al. 2015), suggesting that mitigation measures (e.g., timing restrictions if followed) that minimize human activity throughout the life of the potential Project (e.g., using liquid gathering systems; Holloran et al. 2015) may be necessary to minimize impacts of that activity.

Development Planning:--The DEIS assesses levels of impact by species assuming a uniform distribution of development throughout the Project area (e.g., pg. 4.18-1). Based on the distributional pattern of existing infrastructure in the Project area (see Figure 2.3-1), this is more than likely a flawed assumption. This assumption leads to a situation where impact assessments could either be considered worst case (i.e., all leks and habitats impacted a small amount) or best case (i.e., in reality some leks and habitats will be impacted more than estimated); either way the predictions are likely not accurately estimating impact. Although I do not disagree that it is premature at this stage to expect the location of all infrastructure to be known (see pg. 1-5), obvious flaws in assumptions limit effective decision making in the context of the DEIS providing the level of information required to do so. I suggest developing build-out scenarios based on geophysical variables that may influence gas potential (i.e., built from production data of existing wells in the Project area; see Copeland et al. 2009) to establish – in a spatially-explicit manner – the probability of development within the Project area. This would provide the framework for predicting the location of infrastructure in the Project area, which could be combined with other sources of information important to avoidance and minimization measures to establish a more accurate prediction of infrastructure layout. For example, infrastructure will likely be clumped on the landscape relative to resource location, and the horizontal offset potential described in the DEIS (up to 2 miles) suggests that the companies have the technological capacity to clump infrastructure even more than the underlying resource may suggest.

The approach to planning energy developments suggested by the previous paragraph is critically important for sage-grouse, where the likely effects of relatively discrete levels of development may result in large-scale indirect loss of habitat for the species (Copeland et al. 2011, Holloran et al. 2015). The DEIS specifically indicates that "specific estimates of indirect impacts from project components are not possible due to the programmatic nature of this EIS. Indirect impacts to wildlife species and habitats are [therefore] qualitatively described" (pg. 4.18-1). This is problematic. Informative indirect and cumulative impact assessments require that surface locations of proposed infrastructure are at least somewhat established. From these spatially-explicit estimates in the context of existing conditions, the potential response of sage-grouse populations can be predicted; and these predictions are the metric critical for informed decision making. Otherwise proactive approaches to planning development in the context of multiple use cannot be pursued; we are left instead with qualitatively informed conclusions that are not necessarily helpful in decision making. Consider developing from the aforementioned infrastructure placement scenarios a holistic plan for the placement of development (in aggregate) in relation to areas set aside as wildlife refugia (also in aggregate) throughout the project area. Use these scenarios to inform avoidance, minimization and mitigation to reduce impact to sage-grouse of development while allowing for the full development of the resource (see for example Kirol et al. 2015). Further, within the context of this plan, I suggest re-considering some of the development Alternatives eliminated from consideration (section 2.6), especially phased/concentrated development (pg. 2-46). This approach to planning development would generate more empirically-based information for decision making, and better inform avoidance, minimization, and compensatory mitigation needs at the scale of the Project area.

Invasive Plants:--The DEIS identifies cheatgrass as being pervasive across the Project area, and mentions that in some areas of the Project area cheatgrass is the dominant herbaceous species (pg. 3.14-6). The approach established in the DEIS to managing invasive annual grasses is to limit "further expansion of areas already affected by invasive plant species" (pg. 4.14-5) by arranging for infestations to be mapped to assist land management agencies in the development of treatment plans (pg. 4.14-11). Although it is acknowledged in the DEIS that adherence to Federal protocols "would not completely eliminate the threat of invasion and spread of invasive plant species" (pg. 4.14-12) and that "populations of weedy annual species may become established" for extended periods of time (pg. 4.14-15), the conclusion rendered for cheatgrass in the DEIS is that infestations would be temporary, localized and reversible (pg. 4.14-12 and 4.14-15).

By changing fire-frequency, cheatgrass infestations cause the direct elimination of native shrubs, forbs, and perennial grasses and result in self-perpetuating stands of cheatgrass (Chambers et al. 2007). Next to habitat destruction, invasive plants are considered the second-most important threat to rangeland biodiversity, with many shrub-dominated rangelands throughout the western U.S. having been converted to monocultures of cheatgrass that are now considered steady states (i.e., are irreversibly altered; Sedgwick 2004, Miller et al. 2011). Given restoration technology and knowledge, these altered landscapes are currently considered indefinitely lost as sage-grouse habitat. As a consequence, most land managers emphasize that extreme caution and discretion need to be employed when proposing actions that disturb drier Wyoming big sagebrush sites, especially in areas where cheatgrass may become established and/or spread (as is the case in the Project area; e.g., Connelly et al. 2004, Bohne et al. 2007). Because of this, cheatgrass proliferation in the Project area cannot be considered reversible, and the potential for the indefinite elimination of substantial amounts of sage-grouse habitat must be considered a short-term impact that could result in irreversible long-term degradation. This further suggests that the potential for cheatgrass to become established for extended periods of time (pg. 4.14-15) should be considered residual, warranting compensatory mitigation. Consider taking a more proactive approach to managing invasive plants, especially invasive annual grasses, than the approach described in the DEIS (pg. 4.14-11). I encourage the development and implementation of a comprehensive weed management plan for the Project area following Ecologically Based Invasive Plant Management principles (http://www.ebipm.org/). The University of Wyoming and Agricultural Research Service (USDOA) have tremendous expertise that could assist in this effort.

Residual Impacts:--The impact information presented in the DEIS was used to conclude that: "Alternative B would result in impacts to special status wildlife species associated with surface disturbance, habitat fragmentation, human disturbance, and the potential for granting of exceptions to timing limit stipulations," and in the case of sage-grouse, "all leks in the [Project area] would be at risk of being abandoned" as a result of development (pg. 4.18-72). These impacts were considered residual in the case of sage-grouse for Alternative B, warranting compensatory mitigation. However, it was further suggested in the DEIS that "oil and gas development would have localized impacts on [special status terrestrial] wildlife populations" and that special status wildlife habitat impacted during development could return to pre-disturbance conditions, "which would avoid any irreversible commitments" (pg. 4.18-85). The literature establishes that lek abandonments as a result of anthropogenic disturbance are not solely a product of displacement, but represent a population-level impact (i.e., population size will be negatively impacted; Hagen 2010, Naugle et al. 2011). Further, it has been demonstrated that population trends within relatively small management areas (e.g., BSUs) can differ from trends in the overall management unit (e.g., BLM Field Office; Edmunds et al. 2017), suggesting that an impact could be successfully mitigated at the site level, yet impacts may remain at larger spatial scales (e.g., impacts to a critical travel corridor between seasonal ranges; impacts to a regionally-limiting seasonal habitat type). Therefore, the long-term consequences resulting from short-term use and residual impacts could include the reduction or extirpation of sage-grouse from portions of or the entire Project area, and impacts could extend well beyond the boundaries of the Project area. Because of the philopatric behavior of sage-grouse (see Holloran and Anderson 2005), recolonization of abandoned areas may take multiple generations (Holloran et al. 2010), especially if these areas are large and/or geographically isolated from remaining populations. In contrast to the conclusions reached in the DEIS, the information presented in the DEIS under Alternative B establishes that the impacts to sage-grouse populations will more than likely be widespread. Further, although technically the impacts to sage-grouse populations will not be irreversible, I would contend that considering the impacts potentially irreversible and designing the development and compensatory mitigation plans to collectively guard against the risk of irreversible damage is pragmatic.

Cumulative Effects:--The purpose of cumulative effects analyses is to "ensure that federal decision-makers consider the full range of consequences of actions" when making decisions (pg. 5-1). This was pursued in the DEIS by estimating the cumulative habitat disturbed under Alternative B. Although the numbers presented in Table 5.3-34 appear to be incorrect [i.e., estimated cumulative habitat disturbed under Alternative B exceeds the total acreage of the Project area], Alternative B will more than double the surface disturbance in the Project and surrounding area based on terrestrial wildlife estimates (Table 5.3-28). As with other impact assessments, the DEIS establishes that specifics associated with cumulative effects will be addressed at time of APD (e.g., pg. 1-5). The site-specific scale at which the assessment of potential impact will occur establishes a situation where the cumulative impacts of development may not be realized until regional monitoring metrics suggest an adverse effect has already occurred (e.g., lek count-based metrics assessed at the scale of a BSU or BLM Field Office). Sage-grouse are a landscape species (Connelly et al. 2004), yet within this landscape sage-grouse rely on habitats with a diversity of species and subspecies of sagebrush interspersed with a variety of other habitats (e.g., riparian meadows, agricultural lands, grasslands) that are used by sage-grouse during certain times of the year (e.g., summer) or during certain years (e.g., severe drought; Connelly et al. 2011). The diversity of resources sage-grouse require seasonally and annually must be considered holistically to provide the large, functional, connected habitat patches necessary to sustain populations of the species. As suggested earlier, population trends within relatively small management units can differ from trends in the overall management unit, suggesting that regional-scale assessment metrics may not accurately depict what is occurring in smaller management units (and vice-versa) establishing a situation where the actual cumulative effects may not be noticeable at the local scale at which they are being assessed (Edmunds et al. 2017). This could result in regional-scale (cumulative) impacts to sage-grouse populations even in the event local-scale impacts are successfully managed. The approach to assessing impact through build-out scenarios described above (e.g., Copeland et al. 2009) would inherently address cumulative impacts, and this approach is encouraged.

Mitigation:--The mitigation plan for sage-grouse establishes that "compensatory mitigation applied to the PHMAs must be considered for Alternative B to achieve a net conservation gain," (pg. 6-30) and the list of potential mitigation actions provided in the DEIS (section 6.6.2.2) are appropriate and sufficient for achieving this goal (and I applaud the innovative nature of the objectives established). The proof of course is in the results of pursuing these mitigation objectives. It is extremely important to note that the enhancement or restoration of sagebrush-habitats is not a trivial task. There is tremendous uncertainty as to the vegetative and sage-grouse population outcomes of habitat manipulations. Although managers often justify habitat manipulations with potential long-term benefits, the literature suggests that the long-term effects to sagebrush habitats and sage-grouse of most of the available habitat manipulation options are unknown or negative (Sage and Columbian Sharp-tailed Grouse Technical Committee 2009). Given the uncertainty surrounding proactive management of sagebrush habitats coupled with the need to pursue innovative management approaches to achieve the landscape-scale goals of the compensatory mitigation program (page 6-28), the process of how that mitigation program is developed, implemented and evolves is as important as the actual management actions outlined through the program.

Unfortunately, the general approach to compensatory mitigation described in the DEIS establishes temporal and spatial disconnects in the mitigation strategy; e.g., "the degree of the impact would be analyzed through desktop analysis and ground surveys conducted during future site-specific NEPA during the APD stage of development" (section 6.6.1). This suggests an approach to mitigation that will inadequately address the concerns raised in the preceding paragraph. Again because of the reliance on addressing impacts at the APD stage, impact assessments will be spatially limited and assessed near the time of impact, thereby limiting the ability to address landscape-scale goals and issues of timeliness. I strongly encourage the collaborative and coordinated development of a comprehensive compensatory mitigation strategy that closely adheres to science-based, adaptive management principles (Aldridge et al. 2004, Williams et al. 2009, Williams and Brown 2012). Science-based management requires the rigorous collection and recurring assessment of monitoring data and inclusive stakeholder community engagement, therefore a long-term (at least the life of the Project) commitment is required to implement an applicable compensatory mitigation program. The mitigation program could build from the infrastructure/refugia placement plan as informed through the build-out scenarios described above, and incorporate the weed management plan as an integral component of the compensatory mitigation strategy. In this way, a comprehensive strategy for developing the Project area adhering to Wyoming's sage-grouse conservation goals while providing for the development of the resource could be pursued.

Literature Cited:--

Aldridge, C. L., M. S. Boyce, and R. K. Baydack. 2004. Adaptive management of prairie grouse: how do we get there? Wildlife Society Bulletin 32:92-103.

Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology 26:461-471.

Bohne, J., T. Rinkes, and S. Kilpatrick. 2007. Sage-grouse habitat management guidelines for Wyoming. Unpublished Report, Wyoming Game and Fish Department, Cheyenne, WY, USA.

Burkhalter, C., M. J. Holloran, B. C. Fedy, H. E. Copeland, R. L. Crabtree, N. L. Michel, S. C. Jay, B. A. Rutledge, and A. G. Holloran. 2018. Landscape-scale habitat assessment for an imperiled avian species. Animal Conservation doi:10.1111/acv.12382

Carpenter, J., C. Aldridge, and M. S. Boyce. 2010. Sage-Grouse Habitat Selection During Winter in Alberta. Journal of Wildlife Management 74:1806-1814.

Chambers, J.C., B.A. Roundy, R.R. Blank, S.E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? Ecological Monographs 77:117-145.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, WY, USA.

Connelly, J. W., E. T. Rinkes, and C. E. Braun. 2011. Characteristics of greater sage-grouse habitats: a landscape species at micro- and macroscales. pp. 69-83 in S. T. Knick and J. W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38), University of California Press, Berkeley, CA, USA.

Copeland H.E., K. E. Doherty, D. E. Naugle, A. Pocewicz, and J. M. Kiesecker. 2009. Mapping oil and gas development potential in the U.S. intermountain west and estimating impacts to species. PLoS ONE 4: e7400. doi:10.1371/journal.pone.0007400

Copeland, H. E., A. Pocewicz, and J. M. Kiesecker. 2011. Geography of energy development in western North America: potential impacts on terrestrial ecosystems. Pages 7–25 in D. E. Naugle, editor. Energy development and wildlife conservation in western North America. Island Press, Washington, D.C., USA.

Decker, K, A. Pocewicz, S. Harju, M. Holloran, M. Fink, T. P. Toombs, and D. B. Johnston. 2017. Landscape disturbance models consistently explain variation in ecological integrity across large landscapes. Ecosphere 8:e01775. 10.1002/ecs2.1775

Dinkins, J. B. 2013. Common raven density and greater sage-grouse nesting success in southern Wyoming: potential conservation and management implications. PhD Dissertation, Utah State University, Logan, USA.

Doherty, K. E., D. E. Naugle, and J. S. Evans. 2010. A Currency for offsetting energy development impacts: horse-trading sage-grouse on the open market. Plos One 5: e10339. doi:10.1371/journal.pone.0010339

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Dzialak, M. R., C. V. Olson, S. M. Harju, S. L. Webb, J. P. Mudd, J. B. Winstead, and L. D. Hayden-Wing. 2011. Identifying and prioritizing greater sage-grouse nesting and brood-rearing habitat for conservation in human-modified landscapes. PLoS ONE 6: e26273. doi:10.1371/journal.pone.0026273.

Dzialak, M. R., C. V. Olson, S. M. Harju, S. L. Webb, and J. B. Winstead. 2012. Temporal and hierarchical spatial components of animal occurrence: conserving seasonal habitat for greater sage-grouse. Ecosphere 3:art30.

Edmunds, D. R., C. L. Aldridge, M. S. O'Donnell, and A. P. Monroe. 2017. Greater sage-grouse population trends across Wyoming. Journal of Wildlife Management; DOI:10.1002/jwmg.21386.

Fedy, B. C., K. E. Doherty, C. L. Aldridge, M. O'Donnell, J. L. Beck, B. Bedrosian, D. Gummer, M. J. Holloran, G. D. Johnson, N. W. Kaczor, C. P. Kirol, C. A. Mandich, D. Marshall, G. McKee, C. Olson, A. C. Pratt, C. C. Swanson, and B. L. Walker. 2014. Habitat prioritization across large landscapes, multiple seasons, and novel areas: an example using greater sage-grouse in Wyoming. Wildlife Monographs 190:1-39.

Hagen, C. A. 2010. Impacts of energy development on prairie grouse ecology: a research synthesis. Transactions of the North American Wildlife and Natural Resources Conference 75:96-103.

Harju, S. M., M. R. Dzialak, R. C. Taylor, L. D. Hayden-Wing, and J. B. Winstead. 2010. Thresholds and time lags in effects of energy development on greater sage-grouse populations. Journal of Wildlife Management 74:437-448.

Holloran, M. J. 2005. Greater sage-grouse (Centrocercus urophasianus) population response to natural gas field development in western Wyoming. Dissertation, University of Wyoming, Laramie, USA.

Holloran, M. J., and S. H. Anderson. 2005. Spatial distribution of greater sage-grouse nests in relatively contiguous sagebrush habitats. Condor 107:742-752.

Holloran, M. J., R. C. Kaiser, and W. A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management 74:65-72.

Holloran, M. J., B. C. Fedy, and J. Dahlke. 2015. Winter habitat use of greater sage-grouse relative to activity levels at natural gas well pads. The Journal of Wildlife Management 79:630-640.

Johnson, D. H., M. J. Holloran, J. W. Connelly, S. E. Hanser, C. L. Amundson, and S. T. Knick. 2011. Influences of environmental and anthropogenic features on greater sage-grouse populations, 1997-2007. pp. 407-450 in S. T. Knick and J. W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38), University of California Press, Berkeley, CA, USA.

Kirol, C. P., J. L. Beck, S. V. Huzurbazar, M. J. Holloran, and S. N. Miller. 2015. Identifying greater sage-grouse source and sink habitats for conservation planning in an energy development landscape. Ecological Applications 25:968-990. http://dx.doi.org/10.1890/13-1152.1

Knick, S. T., S. E. Hanser, and K. L. Preston. 2013. Modeling ecological minimum requirements for distribution of greater sage-grouse leks: implications for population connectivity across their western range, USA. Ecology and Evolution: doi: 10.1002/ece3.557

LeBeau, C. W. 2012. Evaluation of greater sage-grouse reproductive habitat and response to wind energy development in south-central, Wyoming. Thesis, University of Wyoming, Laramie, USA.

Manier, D. J., D. J. A. Wood, Z. H. Bowen, R. M. Donovan, M. J. Holloran, L. M. Juliusson, K. S. Mayne, S. J. Oyler-McCance, F. R. Quamen, D. J. Saher, and A. J. Titolo. 2013. Summary of science, activities, programs, and policies that influence the rangewide conservation of greater sage-grouse (Centrocercus urophasianus). U.S. Geological Survey Open-File Report 2013-1098. http://pubs.usgs.gov/of/2013/1098/.

Miller, R. F., S. T. Knick, D. A. Pyke, C. W. Meinke, S. E. Hanser, M. J. Wisdom, and A. L. Hild. 2011. Characteristics of sagebrush habitats and limitations to long-term conservation. pp. 145-184 in S. T. Knick and J. W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38), University of California Press, Berkeley, CA, USA.

Naugle, D. E., K. E. Doherty, B. L. Walker, H. E. Copeland, M. J. Holloran, and J. D. Tack. 2011. Sage-grouse and cumulative impacts of energy development. pp. 55-70 in D. E. Naugle (editor). Energy development and wildlife conservation in western North America. Island Press, Washington, DC, USA.

Sage and Columbian sharp-tailed grouse technical committee. 2009. Prescribed fire as a management tool in xeric sagebrush ecosystems: is it worth the risk to sage-grouse? Unpublished Report, Western Association of Fish and Wildlife Agencies, Cheyenne, WY, USA.

Sedgwick, J. A. 2004. Habitat restoration for Gunnison and greater sage-grouse – a literature review. Prepared for the U.S. Department of Interior Bureau of Land Management Gunnison Field Office. www.western.edu.

State of Wyoming. 2015. Greater Sage-Grouse Core Area Protection. Office of Governor Mead, State of Wyoming Executive Department Executive Order 2015-4, Cheyenne, WY, USA. Available: http://pluto.state.wy.us/awweb/main.jsp?flag=browse&smd=2&awdid=4.

Tack, J. D. 2009. Sage-grouse and the human footprint: implications for conservation of small and declining populations. Thesis, University of Montana, Missoula, USA.

U.S. Department of Interior Bureau of Land Management. 2015. Bureau of Land Management Casper, Kemmerer, Newcastle, Pinedale, Rawlins, and Rock Springs Field Offices Approved resource management plan amendment for greater sage-grouse. Cheyenne, WY, USA.

U.S. Department of Interior Bureau of Land Management. 2018. Draft Environmental Impact Statement for Converse County oil and gas project. Casper Field Office, Casper, WY, USA.

Walker, B. L., D. E. Naugle, and K. E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

Williams, B. K., and E. D. Brown. 2012. Adaptive Management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC., USA.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC., USA.

Wisdom, M. J., C. W. Meinke, S. T. Knick, and M. A. Schroeder. 2011. Factors associated with extirpation of sage-grouse. Pages 451-474 *in* S. T. Knick and C. J. W., editors. Greater Sage-Grouse: ecology of a landscape species and its habitats. Cooper Ornithological Union, University of California Press, Berkeley, CA, USA.